

## REMARKS

The Examiner should note that in the first Office Action originally filed Claims 11-16 were renumbered by the Examiner Gallagher as current Claims 7-12 with the dependency of Claims 8-12 appropriately changed. No change to the text of these claims was made.

The present invention is directed to a non-solid polyurethane structural adhesive composition comprising (1) a controlled structure isocyanate terminated prepolymer composition, and (2) a curative for the isocyanate groups. The prepolymer composition consists essentially of at least 80 wt% of a stoichiometric "perfect" prepolymer and contains less than 2 wt% unreacted polyisocyanate monomer.

Claim 1 is written in Jepson format. The preamble recites as that which is well known in the art: "a non-solid structural polyurethane adhesive composition comprising a polyurethane prepolymer reaction product of a polyisocyanate and a polyol composition and a curative for isocyanate groups." The improvement, or characterization, portion of the claim recites that the polyurethane prepolymer reaction product consists essentially of at least 80 wt% perfect prepolymer and less than 2 wt% polyisocyanate monomer. At page 5/1-6 a "structural adhesive" is defined as a load bearing adhesive and is differentiated from laminating adhesives which are non-load bearing and from hot melt adhesives which are solid materials that are melted at elevated temperatures and applied in liquid form to the substrate. At page 5/15 "non-solid" is defined as including paste and viscous liquids.

The advantages afforded by the defined structural adhesive through the use of the controlled structure isocyanate prepolymer include improved cured adhesive strength, improved ultimate adhesive strength, and improved ambient, or room temperature, development of strength. Examples 1 and 2 compare structural adhesives using prepolymer compositions meeting the two defined criteria, namely the wt% perfect prepolymer and the wt% residual polyisocyanate monomer, with prepolymer compositions not meeting these requirements. These prepolymer compositions were compared in a structural adhesive composition containing the prepolymers of Table 1 and curatives Arcol PPG 2025 and Quadrol. Both MDI and TDI based prepolymers were evaluated.

Table 2 shows that Prepolymer 5 according to the invention gave superior shear strength compared to Prepolymer 6 after room temperature curing and aging for one day and seven days as well as after heat cure and then room temperature aging for one day and seven days. Table 3 shows that structural adhesives containing Prepolymers 1 and 3

according to the invention showed faster room temperature development and strength after one day and superior % cure (1d/7d) than those adhesives containing Prepolymers 2 and 4 which are outside the claim language. Such an improvement in shear strength of the structural adhesives of the invention whether cured at room temperature or heat cured is surprising and unexpected because it is not taught or suggested in any of the prior art.

The Examiner seems to be having some confusion with regard to isocyanate (NCO) content of the prepolymer reaction product and the free isocyanate monomer content as well as the NCO:OH reaction stoichiometry versus the perfect prepolymer molecular makeup. The following explanation is offered.

#### %NCO vs Isocyanate Monomer

Isocyanate content, or %NCO, is a characteristic of the prepolymer that is not equivalent to the isocyanate monomer content. In measuring or calculating the %NCO of a prepolymer, all unreacted NCO groups contribute to the value. Both the isocyanate "monomer" and the partially reacted di- or polyisocyanates contribute to the %NCO value. Thus, the %NCO alone is not indicative of the monomer content of a prepolymer.

#### "2:1 NCO:OH" Reactant Stoichiometry, "Perfect Prepolymer", and NCO:OH Ratio in Producing a Final Cured Polyurethane Bond

2:1 NCO:OH ratio is a common *reactant* stoichiometry used in synthesis of polyurethane prepolymers; however, a 2:1 NCO:OH *reactant* stoichiometry will result in a product with significant "oligomer" content, i.e., non-perfect prepolymer content. As described in US 4,786,703 and US 5,202,001, one must deviate significantly from the 2:1 NCO:OH reaction stoichiometry to attain the "perfect prepolymer" of the present invention. A perfect prepolymer consistent with the present invention can be represented as an A-B-A copolymer in which A is a di-isocyanate reactant and B is a di-functional polyol reactant. A more detailed description is set forth in the present Application, pages 6/19-7/2.

For reference, (comparative) Example 4 of US 4,786,703 describes a prepolymer prepared using a 2:1 NCO:OH reactant stoichiometry as containing >33 wt% oligomer and 2.93 wt% free isocyanate monomer.

NCO:OH ratio is also used in describing the mixing of an isocyanate functional prepolymer with a polyol "curative" in the examples of the present Application. When used in this context, the NCO is the moles of total NCO in the prepolymer. The OH is the moles of

hydroxyl in the curative. The prepolymer NCO group reacts with the curative OH to form a urethane bond.

### THE REJECTIONS

Claims 1-12 were rejected under 35 USC 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. The Examiner alleges Claim 1 is indefinite because it is unclear what is intended by the limitation "consists essentially of at least 80 wt% perfect prepolymers in less than 2 wt% free isocyanate monomer".

Applicants submit that Claim 1 as written does satisfy §112, second paragraph. The entire relevant language reads: "a polyurethane prepolymer reaction product consisting essentially of at least 80 wt% perfect prepolymers and less than 2 wt% free polyisocyanate monomer". The non-solid structural polyurethane adhesive composition comprises (1) a polyurethane prepolymer reaction product and (2) a curative for isocyanate groups. For purposes of examining the claim, the Examiner correctly assumed that the limitation required a prepolymer comprising at least 80 wt% perfect prepolymer and at most 20 wt% nonperfect prepolymers based on the total weight of the prepolymer reaction product.

Claims 6 and 12 have been amended to depend from Claims 4 and 10, respectively. Such amendments should satisfy §112, second paragraph.

Applicants request reconsideration and withdrawal of the §112 rejection.

Claims 1-12 were rejected under 103(a) as being unpatentable over US 5,075,407 (Cody, et al.) in view of US 5,880,167 (Krebs, et al.). Applicants submit that such 103(a) rejection is untenable in that the references as combined by the Examiner neither teach nor suggest Applicants' claimed subject matter as a whole, namely, the defined non-solid structural adhesive manifesting the above-stated property advantages.

Cody is deficient with respect to any teaching or suggestion of the need for a polyurethane prepolymer reaction product consisting essentially of at least 80 wt% perfect prepolymers. Although Cody like several other prior art references suggest reacting the isocyanate and polyol in molar ratios from greater than 1 up to 10, none teach the importance of the prepolymer reaction product containing at least 80 wt% perfect prepolymers in combination with removal of excess unreacted isocyanate monomer to less

than 2 wt% in a non-solid structural adhesive. Cody does not have any example of this combination.

Cody broadly teaches reacting the isocyanate with polyol in an NCO/OH equivalents ratio from about 1.05:1 to about 10:1, preferably about 1.2:1 to 3:1, most preferably about 2:1. Cody's Example 1 shows reacting an NCO/OH equivalent ratio of about 2:1. In the prosecution of US Patent 6,280,561, a Declaration was submitted, copy attached, which shows that the perfect prepolymer content of a prepolymer reaction product from an NCO/OH equivalents ratio of about 2:1 was well below that required by the present claim language. (See also the discussion above on this point.)

The examples in the present Application show the need for the 80 wt% perfect prepolymers and the low free isocyanate monomer content to afford the surprising advantages of improved cured adhesive strength, improved ultimate adhesive strength, and improved ambient, or room temperature, development of strength. Such unexpected results are presented in the data in Tables 2 and 3 of the present Application.

The deficiency of Cody with regard to the combination of the required amount of perfect prepolymer and the limit on the amount of free isocyanate monomer in the prepolymer reaction product is not remedied by the Krebs reference. While Krebs teaches low free monomer content for environmental, health and safety reasons, there is nothing in Krebs with regard to its combination with the requisite amount of perfect prepolymer to afford the advantages demonstrated in Applicants' examples.

In view of the above remarks, Applicants request reconsideration of this 103a rejection based on Cody in view of Krebs and its withdrawal. Believing the Application is in condition for allowance, Applicants solicit an action to that effect.

Respectfully submitted,



Michael Leach  
Attorney for Applicants  
Registration No. 27,349

7201 Hamilton Boulevard  
Allentown, PA 18195-1501  
(610) 481-8519

Attachment